

Disturbed and degraded soils of Kazakhstan

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1. Abstract

The materials of the researches on disturbed and degraded soils of Kazakhstan are presented in the work. The causes and consequences of soil cover disturbances and degradation and its current ecological condition were revealed. The ways of the disturbed lands rehabilitation are presented.

2. Introduction

The total area of Republic Kazakhstan is 272, 5 mln.ha. 222, 5 mln.ha are used in agriculture, 33, 7 mln.ha of them are arable lands, 187, 0 mln.ha are pastures and hay lands, 1, 8 mln.ha are the lands, covered by perennial plants and barren lands.

169, 7 th.ha of lands are disturbed in the Republic as a result of industrial objects and other enterprises construction, mining and process industry development, 49, 3 th.ha of this area are exhausted and should be subjected to recultivation.

The major area of the disturbed lands belongs to the enterprises and organizations of Power and Mineral Resources Ministry of Republic Kazakhstan. Vast territories are occupied by tailing dumps, quarries, industrial dumps. They are contaminated by heavy metals due to the emissions from the concentration mills. Erosion processes were revealed nearby the mining and process industries of East Kazakhstan.

The exhausted dumps of Zyryanovsk and Tishinka deposits were recultivated for nature protection and sanitary-and-hygienic purposes. The rate and direction of soil formation processes are studied at the recultivated (27 years ago) dumps, presenting unique experiments. The biological recultivation of the industrial dumps enables to solve some theoretical and practical problems of the disturbed lands rehabilitation.

According to the data, obtained by the Institute of Soil Science, about 60% of the soil cover in the Republic refers to different degree degraded soils, depending on the peculiarities of natural conditions and their natural-economy usage. The degradation in all regions of Kazakhstan was caused by 3 basic factors: extensive development of agriculture; intensive development of mining industry; wide network of former (period of USSR) military test sites.

The control for land degradation is of great importance in Kazakhstan. About 43% of population (6, 47 mln. of people) live in rural regions, and the majority of them depend on the incomes, directly or indirectly connected with agrarian sector and land use Karazhanov and et al. (1998).

3. Methods

- Field expedition methods of researches, accepted in soil science, were used. General description of the territory, establishment of soil pits, description of morphological parameters according to the genetic horizons with soil sampling for laboratory-analytical researches. Experimental-field methods of researches. Establishment of the experiments on the recultivation of the disturbed lands, caused by mining industry development.
- Geobotanic methods of researches were used for plant cover examination. The determination of phytocoenoses species composition on the disturbed and exhausted uneven age industrial dumps in the conditions of natural overgrowing. The determination of quantitative species ratio in the phytocoenoses according to Drude's method (1890) and method of sight estimation (determination of surface area and projective covering of soil surface). The determination of bioproductivity of over ground and underground biomass by the method of accounting from 1m² and root system by the method of soil-plant mass sampling from the site of 25x25 cm² and from every pit horizon with further washing of roots.
- Determination of mechanical, micro aggregate, chemical composition by conventional methods of soil science in laboratory conditions.

The peculiarity of ecology-geographical situation in Kazakhstan is weak resistance of natural environment to anthropogenic impacts. Desert (45%) and mountain (20%) landscapes, where the main areas of pastures are located, can be referred to them.

The basic areas, suitable for tillage, are located in the northern regions with the most fertile chernozemic and dark-chestnut soils. Chestnut (zone of dry steppes), light-chestnut (desert steppes), brown (semi desert zone) and grey-brown (desert zone) are located further south in dryer climate. Cattle-breeding is developed here and it is possible to develop agriculture under irrigation conditions. Irrigated and dry agriculture is practiced on the piedmonts plains of sierozemic soils.

The soils in the north regions of Kazakhstan are exhausted and 1, 4 mlrd. ton of humus have been lost within more than 50 years of virgin land development. It constitutes 1/3 of the initial stock. The main part of humus is used for the formation of crops. Annual cereals do not sufficiently supply soil with humus. The balance of humus in soil is broken. Arable lands lose humus up to 57% because of erosion processes. The area of eroded soils makes up 19, 1 mln.ha in North Kazakhstan.

According to the data of Land Resources Agency (2006), washed off soils are distributed in the Republic on the area about 5, 0 mln.ha, 1, 0 mln.ha of them are arable lands. The soils subjected to wind erosion occupy 25, 5 mln.ha., 594, 6 th.ha of them are arable lands. There are soils on the territory of the Republic subjected either to water or wind erosion. Such soils make up only 189, 7 th.ha (photo 1, eroded territory of chernozemic soils, influenced by lead-zinc plants).



Photo 1 Eroded chernozemic soil

According to Vinogradov, the degraded pastures made up 47 mln.ha in the middle of 80th (previous century). The total area of desertification makes up 63 mln.ha of pastures (degradation under the influence of technogenic factors). The total economic losses in Kazakhstan, caused by direct and indirect effects of land degradation, are estimated at 93 mln tenge or 6, 2 mlrd. dollars.

Natural environment is intensively transformed at a large scale in the regions of mining industry. Opencast mining occupies the leading place in the world extraction of mineral raw material now. Its specific weight makes up: 34% - coal and 97% - building materials. The opencast mining provides with higher labor productivity (by 3-7 times in comparison with underground mining), smaller cost price of extraction (by 2-3 times). The opencast mining requires less capital investments, opens broad perspectives of complex application of raw material, reduces losses and is safer. But the disturbances of land surface, observed under the extraction of minerals by opencast mining are the most impressing (experience of several decades). Vast territories are used for the development of deposits by opencast mining (Photo 2).



Photo 2 Opencast mining

A slow self overgrowing is in process on the exhausted industrial dumps. The dumps are divided into uneven age according to their species composition and degree of overgrowing. There were revealed old dumps (40-50 years), middle age (20-30 years) and young (10-20 years). The perspective wood-shrub species were determined for the biological recultivation of the industrial dumps. The vegetation (on the dumps of Zyryanovsk deposit) inhabits weathered rocks, places of fine earth rock concentration, and crevices between the psephitic stony-rubble rocks, where moisture and plant seeds, brought from the undisturbed landscapes, are fixed. A mottled-thicket stage of the dumps overgrowing by grassy and wood species is observed here and there.

The experimental-field researches on biological recultivation of dumps have shown that the initial soil formation processes in the spread soil-grounds go on under the influence of soil formation factors (climate, vegetation, pedobionts) Kozybaeva (2004, 2007). The pits, established on the spread soil-grounds, are characterized by a short profile, dwarfishness, and weak horizon differentiation (Photo 3).



Photo 3 Short dwarfish profile of recultivated dumps

It is possible to draw a conclusion from the data on granulometric, physical, physico-chemical and chemical researches that the processes of soil formation can be referred to the zonal type. The phytoameliorants, used in the biological recultivation, well adapted in extremely adverse ecological conditions of the dumps (Photo 4) Kozybaeva (2007).



Photo 4 Dump, recultivated by biological methods

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